The Great Simplification

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[00:00:00] Ed Conway: How can we begin to fathom the future if we don't understand the present? and that's the point. We need to understand how the world works right now. And that means understanding the basics. And I just don't think we understand the basics before we even get to the complex stuff.

[00:00:20] Nate Hagens: Today's guest is Edmund Conway, who is an economics journalist for Sky News in England. Ed is also written for many other publications like The Times, The New Statesman, The Daily Telegraph. he's lectured on international monetary system at the London School of Economics, the U. S. Treasury, and many other places.

He's the governor of the National Institute for Economic and Social Research in England, and he's the author of three books, including most recently, Teal World, which was an economist best book of the year, in this conversation, which is phenomenal and I actually think it is one of the premier must listen to, must watch episodes on this channel.

We discuss six. Substances, six materials that underpin the modern world, sand, salt, lithium, copper, oil, and iron. And in the past, we've had Olivia Lazard and Simon Michaud on to talk about not the energy, but the material requirements for a renewable future. We did more of the same at a deeper level here with Ed Conway.

Underpinning this conversation, I kept thinking to myself, complexity, man, the complexity of our system is so Byzantine and undiscovered and underappreciated. I hope to have Ed back. This was an amazing discussion. Please welcome Ed Conway. Greetings, Ed Conway. Hello, really good to talk to you, Nate. Thank you for being here.

You are an economics journalist based in the UK, and you also recently wrote a book called Material World that covers six materials that are critical foundations, to the world around us today. Salt, sand, copper, iron. oil and lithium. and we're going to, we're going to unpack that, but could you first start by telling us what inspired you as a journalist to write this particular book?

And why did you choose these materials?

[00:02:28] Ed Conway: Okay, so like I should say, right at the start, like a minor amount of humility here. I, you know, I'm a journalist. I'm not an expert. You know, I'm nowhere near as expert as you on, on, on energy. I, my, my background is in economics journalism. And I like storytelling.

And I think that when something is complicated and often interesting, and hasn't really been kind of covered and got the audience that it demands, I often think that there's a place for trying to tell that story and bring it to a wider group of people. And so a few years ago, I guess I, started to, well, I suppose if I really chart it back when I was starting to teach myself economics.

Cause I didn't, I guess I'm a bit of an autodidact. I did eventually go and study economics. I did a course at Harvard, but initially I studied like English literature at university. So I don't have in any way, either an engineering or, an economics background. And then I kind of, you know, Found myself realizing that this was fascinating and that there are many stories here that haven't really been told about, about the world.

But one of the most fascinating essays I read early on in studying economics, was this essay called I, Pencil. And it's by a guy called Leonard Reed in the 1950s, I think, and the idea behind it, I'm sure that you and many of your listeners will have read it.

[00:03:59] Nate Hagens: I assigned it to my students when I taught at university.

[00:04:02] Ed Conway: Okay, it's amazing, isn't it? And it's, just telling the story of how a pencil is made from the first person. So the wood comes from one part of the world, the lead comes from another, you've got the, you know, the metal that holds the eraser in place, the rubber and so on and so forth. But what you kind of learn as you're, listening to this pencil explaining where it comes from is, first of all, it's an incredibly complex supply chain, you know, and no, there is no single person in that supply chain who knows Exactly every stage in how a pencil is made, and when it was written, it was written in the height of the Cold War, and I think for a lot of people, including Milton Friedman, who championed this essay, this, was a really good example of why central planning was not the answer, and why free

markets were the answer, because with free markets, they could, with the invisible hand, architects, this incredibly complex piece of machinery, but I guess the second lesson that always kind of stayed with me, I remember reading years ago was like, wow, that's how a pencil is made.

It's like a truly interesting, deep, gritty story. And I kind of just wish I had been there. I knew the same thing for everything. I knew the same thing for every product I encounter on a daily basis. And I bet, I thought at the time, those stories are just as fascinating. And so to some extent, this book kind of came out of the same kind of inspirational point.

I wanted to do the same thing for lots of different products we touch every day, but also kind of underlying it. In my day job as a journalist, I kind of go and visit a lot of places, and I happened to visit a gold mine a few years ago, it was for a totally unrelated story, something about Brexit, we were, we had, I think, just voted to, to leave the European Union at the time in the UK, it was a big story, and one kind of little sub story there was a lot of our trade figures, the export figures for the UK, they were being distorted, because we are one of the biggest entrepots for gold trading, physical gold trading in the world in the UK, it's like a hangover from empire, I guess, and the gold standard.

And partly as a result of that, a lot of gold flows in and outta the uk. And just to illustrate this point about data, you know, about gold flows and how it looks like we're trading a lot with Switzerland, when actually a lot of that is gold. I went to a gold mine in Nevada and just. Trace that supply chain.

And I did the story and that was all fine and great. But actually the thing that stayed with me was standing on the lip of the gold mine, looking into this enormous hole and just thinking, gosh, that's, so that's how we get gold. I just hadn't realized it. I hadn't realized, you know, they were tearing down an entire mountain to get gold.

And I thought to myself, well, if that's what we do for gold, then what do we do for the other stuff? Because, you know, this, genuinely blew me away. I kind of thought I was a relatively kind of seasoned economics writer, and I'd never kind of really understood the realities of resource exploitation, both, in the vastness of the scale

and how impressive it is, but also the, environmental and social consequences thereof.

And I thought, well, that's, kind of wild. What do we do to get the other stuff? And in fact, come to think of it, okay, gold's pretty important, but although a lot of people would argue not half as important as certain, you know, some investors thing, but in that case, what, are the things that we really do need?

You know, and the funny thing was, like, for civilization to function, I kind of assumed as someone who's quite data centric that Somewhere there might be some spreadsheet which says, okay, here are the key materials that we need for modern economies to actually function. You need fiber optics because without the fiber optics your entire, you know, you don't have the internet.

You need steel because you need structures within which people are going to live. You need fertilizers, you need concrete, you need all of these things, because Although that stuff, when you look at GDP, like measure like gross domestic product, that stuff doesn't really play an enormous part in GDP, a lot, well, you know, not as big as, for instance, you know, social networks, but without fiber optic manufacturers, you don't have social networks.

You know, without the servers, you don't have the, services sector. And so that kind of led me down a strange route, which turned out to be, like I say, there was no spreadsheet which said, okay, here are the six materials you really need. So it was a bit of a journalistic journey just to understand what are the things that we really, need without which everything else kind of grinds to a halt.

And then I went down the road of, you know, going, to all of the mines and going to all of the places where the. You know, the oil and gas comes from, and it was a fascinating journey. Welcome to

[00:08:48] Nate Hagens: my world. I've been unpacking the story for 20 years. You know, just as an aside, it would be wonderful if economic students and other students in college could have a mandatory field trip to a gold mine or something like that, just to, to, See it beyond supply and demand curves, to see the actual mechanics of, such a thing.

so getting to your book, let's start, and we're going to briefly go through most of these, if not all of them, let's start with sand. how has sand acted as sort of a jumping off point for the rest of these materials and what about sand makes it so versatile and important?

[00:09:29] Ed Conway: Well, with sand, I mean, with sand, it is the biggest of all of the sections of my book.

So there's, six things. There's sand, there's salt, there's, iron and copper, oil and lithium. And obviously it's not an exhaustive list and, you know, the, there are many other materials are available. However, sand is great because within sand, there are there are, I chose three different products that are pretty, Significant for the modern world.

I chose glass, is obviously melted sand. It is, you know, arguably the first advanced technology that humankind ever made. Yet, although it is Ancient. We still need glass in its incredibly advanced forms to make silicon chips because you need glass lenses to bounce lasers off to, to kind of make the transistors that are incredibly small on, on silicon chips.

You need glass in the form of fiber optics to, for us to communicate even these days, we're, communicating. Most of the data here is traveling on glass in fiber optics. And so it kind of bookends civilization to some extent, glass does as a material. And yet, you know, it is ultimately made from sand, very particular types of sand.

So silica sand, that's pretty high in, in silica content. And so it's just, To be honest with you, I always knew that was going to be the first thing that I was going to write about and I expected I would just whiz past that chapter really quickly and get on to the sexy stuff like silicon chips.

Silicon chips was always, I wanted, to go back to that point about iPencil, I wanted to do iPencil for silicon chips. I wanted to be able to lay my hand on the quarry where the silicon comes out of the ground and then go follow the journey of that silicon atom all the way around the world. And I did that.

So I was I had that in my eye and I was like, right, let's get glass out the way. And it turned out to be just utterly, fascinating and far, kind of longer a chapter than I expected. Partly because there's lots of historical lessons. and partly because, like I'm one of the wildest stories in there.

I think is, this episode, The Glass Famine, that happened in, in 1915, or actually, slightly earlier, in, in the world, World War I, we used to, in this, in the UK, to be one of the world's biggest glass manufacturers, and we made very advanced glass, and when you think about what glass does. it is pretty extraordinary.

You know, it's a silicon technology that enables us if we're, if it puts, if you put it in eyeglasses to extend people's working life because people can then see, they can read. if you look at advanced optics, this is what helped us to understand, you know, things like the, nature of light. It helps Copernicus to understand the universe.

This is, you know, an amazing, or Galileo rather, this is an amazing technology which has enabled scientific discovery all along the way, so to some extent it's like a general purpose technology. But at the point of the kind of, in the Victorian period, the UK used to be a really big producer of glass, and there were lots of people who were hobbyists who were trying to work out how to fiddle around with glass and make different types of lenses and things.

And then the British industry just kind of died and it died partly because it was overtaxed and it died partly because there was just a bit more investment in money happening in Germany at the same time. And so a lot of glass production shifted to Germany. by the turn of the 20th century, some of the world's, you know, basically the world's best lenses are being made by Zeiss in, Jena.

They still are today. and, Then comes World War I, and the UK kind of realizes, Oh, hang on, where are binoculars gonna come from? And this is like the first, great war that's fought, where your armaments are able to, fire far fur far further than you can actually see, And binoculars, you're You know, whether you have binoculars or telescopes or sniperscopes is, very consequential indeed, that's the matter of life and death, and Britain was importing 60 percent of its binoculars and optics from Germany, and you have this moment, and what's fascinating about it is twofold, first of all, We got really desperate and we, it's, this moment where, you know, we're

talking about things that don't play a very big part in GDP, you know, glass wasn't a massive part of, our GDP back then, but all of a sudden, the, fact that we didn't have the binoculars we needed to wage war was, you know, existential for this country.

It was absolutely existential

[00:14:00] Nate Hagens: to the extent. Casual observer would think that bullets or tanks or airplanes would be the limiting variable, but, binoculars and glass.

[00:14:09] Ed Conway: Which they were, but it was, yeah, without the glass, without the lens to be able to fire that you, they were useless. and so this thing's got very desperate for the UK and to, to the extent that in 1915, we sent spies to do a deal with the Germans to buy binoculars off them.

we were short of glass, they, it so happens, were short of rubber, and the UK, through its plantations in Malaya, controlled a lot of the global supply of rubber, so we agreed. You know, the documents are there in the National Archives in the UK, we agreed to sell them rubber in exchange for some Zeiss binoculars, all the better to kill each other with, you know, it's a shocking story, really.

But what's interesting about it is, you know, how easily you can allow an industry to just wither on the vine, which is kind of what the UK did. But by the same token, actually, the, aside from the fact that, you know, journalistically, there's no, there's a great story there in that spy going off to Switzerland to do a deal with the Germans, what's even more interesting to me for the current juncture of where we are, and this is relevant to the UK, relevant to the US as well, is that actually in the following years, so in 1916, 17, 18, the British Did rebuild their glass industry.

Okay, so by the end of the war, we had a massive glass industry to the extent that we were able to share to export glass. When I say glass here, I mean basically lenses and binoculars and optics. We were able to export it to our allies in the war. And what does that show? That shows that you can rebuild a seemingly dead industry.

In extremis, if you need to, you can do these things. And I just think that's quite a kind of useful lesson, given where we are right now with all of the stuff that we're

talking, you know, that Doubtless will talk about. So that was a big deal. But I've gone off on a tangent. Glass was one part of it. Then there's concrete, which is another key element.

critical material, which obviously cement is the main ingredient there. You make it in part with sand and then you need to add sand and aggregates to it in order to turn it into concrete. Without concrete, we don't have the urban environment as we know it today. it is just impossible to imagine how urbanization could have happened as rapidly as it has in the past hundred years without concrete.

It has totally changed the game, but it is also a massive carbon emitter. and then you have, silicon chips. Like I said. I, think, my book is like one of the only, if not the only place where you do really have that full journey all the way from the quarry through to when you're, you know, you've got your device.

that's where it comes from. And I had, there's this weird thing where I was talking to all these people within semiconductors saying, okay, so where does the silicon come from? And they're like, who cares? And I'm like, I care. I want to know where the silicon in the silicon chip comes from. And, it was.

An unexpectedly difficult question to answer because people, you know, people who work in like TSMC or Intel, they don't really care. They just, it just turns up as a silicon wafer. But actually it turns out that journey, you know, the journey that you have of a silicon wafer within a fabrication plant like TSMC is amazing.

It's, it is, and if you haven't already read it, Chris Miller's Chip War is a brilliant book on this, which tells you a lot of that story, a lot of that history. And the size of the transistors you can. Get on these chips. They are so small, you know, they're smaller than a red blood cell, smaller than a white blood cell, smaller than a coronavirus.

They are so small, they are smaller than the wavelength of visible light. So they are literally invisible. Like, I don't dispute that's an extraordinary thing that we humans are capable of doing. However, my point is just to say There are other amazing things happening on the way to that factory, you know, for that silicon, piece of silicon that comes out of the ground as a hunk of rock, to be converted into this purest thing.

it is the purest thing that humankind can make, both in chemical terms and in atomic terms. I find that kind of equally mind blowing, and it's a story that we haven't really discussed as a, you know, enough.

[00:18:06] Nate Hagens: I'm recognizing that we could probably spend this whole 90 minute podcast on, just one of the elements, materials in your book, like sand.

How does sand relate to silica?

[00:18:19] Ed Conway: Well, silica, sand is just a type of, it's a type of sand. Actually, technically, okay, so if you're talking, if you're getting really pedantic with kind of sand experts or geologists, sand. The term sand is basically any grain below a certain size. Okay. So there's something called the Udden Wentworth scale, which says if you go beyond a certain size, then that is now a sand.

So actually, technically grains of salt, that's also a sand. Salt is a sand. but. In practice, and also a lot of what we call sand these days, like the stuff that you walk on a Caribbean beach, a lot of that's not actually silica. A lot of that is just kind of ground up bits of parrotfish excrement essentially.

but the sands that in this case I'm talking about is. Parrotfish excrement? Correct. Correct. It is the parrotfish eats the bits of coral reef, poops them out of its behind. They go onto the ocean floor, they get washed up, that's, that becomes, you know that beautiful white sand that you often see on the most beautiful white kind of Caribbean beaches and kind of coral areas, that you're walking on parrotfish poo, I'm afraid to tell you.

[00:19:33] Nate Hagens: the sand that's used in industrial processes like glass and some of the other things you mentioned originated as a silica rock that was then crushed into sand like particles.

[00:19:44] Ed Conway: Often, yeah, often it starts, it kind of goes through these cycles of being compressed into rock and then gets kind of gets eroded away.

And because the silica, because silica is really hard, the kind of grain of sand is the last bit that remains. so that's, yeah, and it depends, and you've got lots of different types of sand, you've got different types of, you know, shapes of sand. so

you've got angular types, you've got kind of stuff that's been, kind of eroded away into circles.

You've got the chemical differences, so some that have high silica content, lower silica content, and also other bits beside.

[00:20:16] Nate Hagens: So the Caribbean white sand beach is not useful for industrial inputs. Where do we get most of the sand in the world? and are there risks of resource shortages for sand in, in the future?

And what would be the implications of that?

[00:20:33] Ed Conway: Yeah, I mean, silica sands, like, broadly speaking, there's a lot of sand, so we're not going to run out of sand. The issue is, there are certain types of sand which are relatively scarce, the sand that you use in construction, It's I wouldn't say it's scarce exactly.

but it's because there's, lots of it out there. It is just quite difficult to find it in a place where you can take it and not destroy the local environment. Okay. So it's often in rivers. Okay. And you see what's happening in the Mekong Delta, in Cambodia, Vietnam at the moment, you know, that, that is, You get a lot of sand mining there and it is, it's, kind of destroying the ecosystem there.

and you get lots of sand mining there because there is, there's a massive appetite for construction and you need good angular hard grains of sand to put into cement and to concrete and to make them into the buildings

[00:21:30] Nate Hagens: angular subcomponents. Exactly,

[00:21:38] Ed Conway: because it's because essentially, you know, the glue is kind of mixing around each grain and the more angular it is, the more it's kind of catching and creating a hard, kind of structure within itself.

By the way, that like, again, I'm no cement expert, but I spoke to quite a few in the process of doing this. I mean, that's kind of what I do. I do. I talk to the experts and hopefully take their words and turn them into a

[00:22:05] Nate Hagens: story. For what it's worth, in case I, missed the opportunity to say this later, that skill, what you're doing is incredibly important in our world, is, dispelling the energy and materials blindness of our current culture.

you probably have enough topics for the rest of your career ahead of you, I can imagine.

[00:22:27] Ed Conway: Well, I didn't expect, I didn't expect, this is another tangent, but I, did not expect when I started writing this book, you know, I haven't, I, as you'll notice already, I haven't framed it so far in terms of energy.

And when I started on this journey, I didn't expect to be writing a book about energy, but in the course of writing, I just realized, you know, What you've known for a long time. It is everywhere. it is kind of everything. And by the time I'd finished writing the book, I'm like, hang on, this is also a book about energy.

It's about energy transitions. it's about net zero as well, but it, I didn't set out with that kind of expectation. But, I was going to say that the scientists I spoke to, you know, who, who deal with, cement and concrete, who, by the way, are fascinating people. massively underrated, field is cement research.

Still, even today, you know, hundreds of years on from the discovery or rediscovery, depending on how you want to frame it, of, concrete, because the Romans knew how to make concrete. We kind of forgot the recipe for a long time, and then we came up with our own modern version of it, Portland cement, in the kind of But the Romans used sand.

Yeah, they use sand as part of it. it was a particular, they used a particular type of kind of volcanic ash as the binder in there. So the sand in this case is inert. You know, the sand and the aggregates we put into cement and into concrete, they're not really. doing anything, they're just helping to create the structure because they're really hard.

The magic thing is mostly the kind of lime, in the case of, limestone, which we, which, you put into a, kind of cement kiln. But what I was going to say is, what's happening within cement when it's setting? remains one of the great mysteries of

science. People are still trying to understand the physics of cement when it's setting today.

And I kind of love that because we're all a little bit sniffy about cement and concrete these days. It's, you know, this ugly ubiquitous thing. But actually, if you kind of note that, first of all, what's happening in there is kind of a mystery and people are still trying to understand it. Secondly, that the concrete, to some extent, is still almost alive.

Because even old cements, and concretes are still curing long after they've been set in place. And that's still often sucking in carbon dioxide from the atmosphere and starting to, to change their chemicals structure, which again, I think is, you know, I think it's an underrated, material both in terms of what it does and in terms of how interesting it is.

Over

[00:24:58] Nate Hagens: time, buildings and built structures that have concrete are actually absorbing CO2.

[00:25:05] Ed Conway: Correct. they are absorbing it, but the net terms, they, you know, you, you're, emitting far more carbon. Five or 6 percent of global CO2 emissions or something like that. Correct. Yeah. It's kind of similar to steel, maybe a bit more than steel.

And half of that is the kind of the coal or whatever you're putting into the. into your kiln to heat it up. So that's kind of relatively easily dealt with. The other half is far more difficult, which is that when you're kind of heating the, limestone and the stuff you're grinding up in there, there's a chemical reaction where it just emits a lot of carbon and no one has worked out how to make this stuff without that chemical reaction.

So it's not, the. energetic side, it's the chemical side that is the really tough nut to crack when it comes to cement. and then you, and what I kind of found going around this, you know, all of these different materials is you kind of encounter that quite a lot. So to make, a silicon chip, so that journey from the quarry through to, the, smartphone.

And by the way, it's the same process for a, for, like a solar panel. It begins with a lump of quartzite, you, get out of a quarry, you throw that into an electric arc furnace alongside some wood chips and some coal, and the wood chips and the coal, mostly the coal, are doing an incredibly important function because you're smelting down that silicon and you end up with metallurgical silicon which is 99 percent pure and it looks like a metal.

You, the coal, In this furnace, as in a blast furnace, is doing an incredibly important job of basically stealing, grabbing the oxygen off. the quartzite and taking it away and then emitting that in the form of carbon dioxide. And so there's a chemical as well as an energetic, process that's happening there.

And it generally, this, like, again, I'm, no expert on this, but it seemed to be when I encountered this, that often the chemical thing is the harder thing to deal with. Than the energetic side of the process. Not to say that the energetic side is, not difficult to, fiddle with. yeah, that's, it's kind of interesting, both with sand, both with silicon chips and with, with concrete that's the same.

[00:27:28] Nate Hagens: so let's get back to where the sand comes from. Excuse me. Does, every country. have their own sand resource? or is a special types of sand so uniquely valuable in their properties that they're exported, which requires energy and other costs? Yeah. and are we, is there such a thing as peak sand?

Of course there's plenty of sand, but the quality and availability without destroying ecosystems, et cetera. what can you speak to about that?

[00:28:01] Ed Conway: like. There's, it kind of depends on the sound that you're talking about. Let's say silica sand, for instance, they used to make glass. It's, not that widely distributed.

You know, it's not everywhere. You need quite high kind of level quantities of silica in there, kind of over like 90 percent of high nineties. And that's not easy to find the UK. For instance, we didn't think we had that much in the way of silica sand, until back in world war one, then people got a bit nervous about it.

because actually, World War I was okay, because we got most of our silica sand from quarries just outside of Paris. and France hadn't been invaded at that point,

so we could still get the sand. World War II was more, more tough, because obviously France was invaded by the Nazis, we couldn't get the sand that we needed, and so we needed to find a new place to get the sand from to make the lenses that we needed to make the binoculars to try and kill the Germans.

And we found some sand in a very distant part of Scotland. and I suspect there are quite a lot more of these places if you so need it. So I don't, I'm not especially worried about running out of kind of silica sand. there are certain types of very obscure sands like, well, so then you've got the kind of environmental things.

So with construction sands, We shouldn't run out, but looking for kind of submerged riverine systems, which is kind of the best way of getting this stuff, is kind of expensive. So a lot of British sand, and actually the same I think for, let's say on the kind of, east coast of the U. S., Quite a lot of that sand comes off, kind of, is submerged sand that's not far off the coast.

Same thing in the UK, it comes off, like in the North Sea, there's quite a lot of sand. The Rhine, used to empty into the North Sea and create this enormous river system, Actually, a long time ago when the UK, back in the Ice Age was connected by, this land to the continent, there was this area called Doggerland.

that's now submerged because the sea level has risen, and so what you have there is old riverbanks that are no longer actually riverbanks. You can go in there, quarry the sand, it's totally great, you bring it back, you make concrete out of it. It's quite fascinating, actually, because often the people who are dredging the sand, they're discovering these old, like, Iron Age, well actually, sorry, more like kind of Neolithic axes and things, and Rhino, kind of great woolly mammoth, skeletons and things like that, while they're dredging for the sands that we're using to turn into concrete to, to, make London, bigger.

I don't think there's a, like, a fundamental, like, geological shortage, but as I say, that is more expensive to do than, like, than just going with a truck to a river and just digging up some sand and taking it off to a building site. And what's interesting about You know, about these materials in general is that when I started writing about my materials, a lot of people were like, Oh, you're going to do like nano materials and you're going to do all of these kind of amazing things we can make these days.

But the point was, no, I wanted to do materials that we do at scale and part of the reason concrete has changed the world. Partly it's because it's an amazing material in kind of chemical, physical terms, but partly it's also just because it's got a very forgiving recipe, and we, you can find most of the ingredients in quite a lot of places, like lime, actually lime is the more important one for, cement, so limestone, you can find that in quite a few places, but also, It's pretty cheap.

It's cheap. And, you know, concrete changed the world because it's cheap. Steel changed the world because it's cheap. Oil, you know, has been pretty cheap for a lot of time, and it's changed the world. And those things actually matter, but again, within my world of economics, I don't think we discuss that.

Enough. so back to your question, I don't think we're going to run out, but the issue is it just gets more expensive when you're doing it in a more sustainable way that's not destroying ecosystems. Shall I say there's one other type of sand, just like, which is quite a cool type, which is called ultra high purity quartz, and we use that type of sand to make the crucibles, In which I mentioned that long process to make silicon chips.

It's really long and I won't kind of bore you with it. It's in the book. but along the way you need to kind of melt down the super, pure silica, or super pure silicon at that point. and you need to melt that into a really high purity crucible. There is only one place in the world where you get the sand.

that you turn into that crucible, or at least one place you can get it in large quantities. And that's, a mine called, or a place called Spruce Pine in North Carolina, in, in the US. so far they've only found one mine that has large quantities of that stuff in the world. So that is super, super scarce.

And if that place goes down, then we're in big trouble. But like I say, you know, you've got, Probably if that place goes down, the price of this stuff goes through the roof and then we find a new source of it, but it's just a gritty few years while that exploration process happens.

[00:33:01] Nate Hagens: No pun intended.

okay. Wow. let's move on, to salt. salt has a pretty fascinating, history in the human world. having historically been a store of value, a way to accumulate power, from what I learned from reading, your book. So in what ways does salt today act as an indispensable component of the global industrial economy?

[00:33:31] Ed Conway: Yeah, I mean, it's a really good question because there's some great, there's some great books actually about salt. The most famous is the one by a guy called Mark Kalansky. but most of them are kind of primarily historical, I guess. And what, I found Just as interesting and there are loads of great historical stories about salt and I feature quite a few of them in the book It's a you know, it's a tool of power.

It used to be really valuable Used to be kind of used as a currency. It was traded for gold And in some ways it's been taxed forever So in some way when you look at kind of despotism and government power Salt is a really good method through which to look at that story But what I was just as interested in is the fact that these days You Most, well, 90 percent of pharmaceuticals begin with salt.

So you begin with salt and you refine it into, or you'd rather go through various chemical processes that leave you with kind of chlorine based chemicals. those chemicals are not just the bedrock for the pharmaceutical sector, but they're the bedrock for all sorts of products that we don't really think about all that much these days.

You know, if you want to make glass, you need soda ash. If you want soda ash, you need salt. Soda ash is made with salt, for the most part. There's actually soda ash mines in the US, so there's a whole other thing about that. but, for most people, soda ash begins with salt. If you want to make, let's say, the batteries, lithium ion batteries, so you need lithium hydroxide.

How do you get lithium hydroxide? Well, you get your lithium salts out of the ground. Heh. And then you need to turn them into a lithium chemical. Well, how do you do that? You do it with caustic soda, sodium hydroxide. And where do you get sodium hydroxide from? You get it from salt. Salt is still, today, bedrock for a lot of the chemicals sector.

All of the chemicals that don't come from oil basically start with salt, or a lot of them. And, We, in the UK, used to mine a lot of salt. We were, you know, in our less proud kind of history, as a kind of imperial nation, we would go to places, like the countries, you know, in Africa, or we'd go to India, and we'd say to them, Hey, don't make your own salt.

And they're like, what the hell? And we're like, well, could you just buy our salt off us? And they're like, well, no. And we're like, okay, we're just going to tell you to. And so we, you know, shut down the salt works. And that's kind of what happened in India. And part of the story of Indian independence is, Gandhi marched to, to go and make salt because he was underlining the, just how iniquitous it was that the British wouldn't let the Indians make their own salt.

Anyway, in this period, we were producing salt that we sent all around the world. It was a source of great pride. It was, it came from Cheshire, from the great salt, strata that, underlie Cheshire. the irony now is that, is today, this de industrialized nation which is what we are, we produce like two or three times as much salt as we did back in our Victorian heyday.

And we do because, A, it's much easier to, mine out the ground, you just use something called solution mining, you're sending down water and up comes brine. But B, because we have quite a big chemicals industry, and that is fed with salt. And I went to some of these plants where we get salt out of the ground and we turn it into products that we end up using.

Soda ash to make paper, you know, to make glass. chlorine to turn into bleach and cleaning products. It comes from salt. so the salt that's

[00:36:54] Nate Hagens: in our food and we buy in the supermarket to bring home to cook with, that, that's a tiny fraction of the salt use in our global industrial economy. it's

[00:37:04] Ed Conway: a fraction of it, yeah, it's a small fraction of what we make in the UK and the US, the majority goes to chemicals, and it goes to chemicals that you think have nothing to do with salt, like PVC pipes that, that are everywhere, they are made in part from salt because the chlorine in them, comes from salt, polyvinyl chloride.

we purify our tap water here in the UK and I presume in the US with, chlorine. The chlorine comes from

[00:37:30] Nate Hagens: salt. Can't, we get chlorine other ways or is this where it's the cheapest and, largest

[00:37:35] Ed Conway: scale? This is by far and away the cheapest and largest scale as I understand it. It's a really good question.

You, you can't, what I do know is you can't ship chlorine very easily because it's, you know. It's a chemical weapon, it's incredibly dangerous. So you ship salt instead? So you would ship salt or rather you would just probably mine the salt locally. But chlorine, you know, I went to this plant where they get the brine and they turn it into, it's actually an electrolysis process that uses incredible amounts of electricity, these cells.

This one cell room uses more electricity than the city of Liverpool. they there basically provide 98 percent of the chlorine for the UK. One room. This guy said if this place goes down, within seven days we're rationing tap water. and there are these plants everywhere around the world. We don't spend much time thinking about them, but they are our life support system.

And it begins with salt. And no one, as far as I know, really spends much time thinking about this. But we're alive thanks to

[00:38:39] Nate Hagens: it, you know? Well, as this conversation unfolds, I'm getting the feeling that we have a lot of life support systems that we're unaware of, in the complexity and materials that are kind of invisible to us.

I mean, ironically, where I live here on the, banks of the Mississippi River, we have salt mines here like caverns, under the cliffs by the Mississippi River and, sand that is used for fracking. in my own county where I live and most people here, including me, don't know the story that you're telling about salt and sand and, how important they are.

Yeah, frack sand is really important as well. You know, that's another one I, barely had time to mention. One of the things that I'm advocating for, I'm, referring to as

Goldilocks technology, which is, I don't think we're going to have. well, the energy is one part, but the, massive scaling of materials that would be needed for a net zero future, I just don't think we have 10 to 100 times the copper at affordable rates.

And we're going to get to copper in a second. I think an intermediate technology, we can use abundant materials to give us. 80 percent of the benefits of a technology with 20 percent of the inputs. So what are your thoughts on sodium salt based batteries as opposed to some of the really energy and material intense expensive batteries being used today?

Yeah, I mean,

[00:40:15] Ed Conway: I think they must have a place. and actually what's interesting, so I talked about soda ash. I think I'm pretty, I think I'm right in thinking that the sodium in sodium ion batteries generally begins as soda ash, so sodium carbonate, which begins as salt. Okay. So you're right.

It starts as salt in most countries, but in the U S and Turkey and a few other places, you've got these massive, deposits of soda ash. So actually I think, and again, I'm, no expert on sodium ion batteries, but from what I have read into it, and from what I understand, you know, picking apart the other bit of my expertise, which is kind of understanding a bit about mining and where resources come from, you know, I think the U.

S. could have quite an advantage, a mineral advantage there because the cost for the U. S. of getting soda ash is much lower than most countries around the world because you don't have to, you don't have to get that brine and put it through a very energy intensive process to turn the salt into soda ash.

but to answer your question, yeah, I think there must be a place for these alternative and slightly lower density energy storage, media. The only kind of thing I'd say is that. With lithium, which obviously is the big one when it comes to energy storage, and perhaps we'll talk about it, because it's one of my materials, I do think that we have enormously ambitious targets for the amount that we want to mine of lithium.

But we are also really early in the curve of lithium exploration and discovery. you know, we have We've really only just started thinking about where lithium might come from. I, like, with copper, with iron, with all, pretty much every other element in the periodic table. Well, not every other element, but loads of the kind of industrial metals.

We have thousands of years, certainly with copper and hundreds with most other materials, of working out where they are and putting a lot of money into exploration. With lithium, it's kind of only just begun. So I do think that there might well be A lot of big discoveries to come on lithium. That means that what at the moment looks like it's really quite scarce and critical might in a few decades time come to look like it's much more plentiful.

But I don't know. That's

[00:42:34] Nate Hagens: my guess, you know, and real briefly, because we have a lot of materials yet to cover. Why is lithium so special and important in the global economy?

[00:42:46] Ed Conway: Well, just I mean, it's just because of it's there's nothing else on the periodic table that has the potential as an energy storage kind of metal.

and so it has that place. It's very light. It's very it's it's energy dense. Obviously, it's not energy dense compared with things like hydrocarbons. But it's energy dense as a kind of storage medium. and we've kind of cracked the technology as well, which I think matters. You know, we spent about a hundred years trying to work out how to make a decent lithium battery.

It's a forgotten history really. Thomas Edison was playing around with lithium back in, in the turn of the 20th century. but it took all the way through till the 1970s for us to actually master lithium ion batteries. And really, it's only thanks to that we have the smartphones or the electric cars that actually are pretty decent these days.

You know, electric cars existed back in the early 1900s, but they were rubbish because the batteries were rubbish. Today, electric cars aren't rubbish anymore because the batteries are good. the whole story of batteries You know, of electric

vehicles is about having decent batteries and the whole story of having decent batteries is the fact that it took a very long time to work out how to tame lithium, which is a, as you know, from, you know, chemistry experiments at school, it's very reactive.

It tends to explode and to go up in a puff of smoke and flame. but so it took a long time to tame it. But now that we have tamed it, it is, you know, A pretty exceptional store, of, power. And, so it is, you know, it is central to, to pretty much every, trajectory we're looking at in the future, but as you say, Like the thing that I get a bit frustrated with, and you I'm sure have it too, is whenever you're talking about this stuff, I hadn't realized again when I was writing this book that it would be a bit about energy transitions, you kind of find yourself encountering the hydrogen guys, and it's all about hydrogen, and then you bump into the battery people and they say, oh don't talk to the hydrogen guys, they're full of shit, you want to talk to what?

And then you're talking to some other guys, that geothermal guy, and it's like, oh my god, God, like, surely the future is this, you know, it's a patchwork of so many different technologies, I assume. Maybe, on your business card you

[00:45:02] Nate Hagens: should have a hyperlink to the iPencil essay and send it to those people.

maybe. You know what I

[00:45:09] Ed Conway: mean

[00:45:09] Nate Hagens: though, it's like, everyone's got their thing. Believe me, and that I mean, that's why I appreciate the breadth of your book and you're still, you know, exploring and learning about these things. We live in a complex system. It is not a reductionist story. We have to look at the relationships of ourselves and other humans and the environment, but also the relationships of all the inputs and how they interrelate.

And I'm going to hold off on asking you this, right now, because I want to get to copper and oil, but I am. Thank you. As you're speaking, I'm wondering what the 21st century equivalent is of the, World War II binocular shortage, in the UK,

because there could be hundreds of such candidates, given the complexity of our system.

Yeah.

[00:45:58] Ed Conway: When you look at, when you look at our dependence on, on, for instance, China for batteries, it's greater than the UK's dependence on, on Germany for, for, binoculars back then. And that's just one thing, you know, wind turbines, lots of other things as

[00:46:12] Nate Hagens: well. So let's move on to copper. In your book, you describe copper as, being in basically everything.

Especially the tech gadgets that have become ubiquitous in our world. So how, critical is copper to our modern way of life? Is it substitutable? And, are, we running out? and this I've looked at myself a little bit. So what are your thoughts?

[00:46:37] Ed Conway: Yeah. Well, correct me if I, if, I could have make any errors, I mean, it is substitutable because there are other things that can conduct, I mean, you can use aluminum, aluminum.

I know I'm supposed to say it's actually, but aluminum is a better We, in the UK should be saying aluminum. And I know that anyone from the UK hearing that will, choke on, whatever the, drinking, but it's, you know, British English is, you know, it's the Queen's English or the King's English, but then I discovered that we added this IUM thing at the end of aluminum and it really shouldn't be there based, you know, it's alumina.

but listen, so, to go back to your, to go back to your point, yeah, obviously it's substitutable, but. It's aluminum's, no way as good. silver. it would be amazing, but obviously it's, much more scarce and expensive. And the thing that, I guess the thing about copper is just that it's like with steel, it's that, that you say Goldilocks earlier.

It's, just the right kind of performance plus the right kind of availability. and, The trouble with copper is that there's not, you know, I, people like to talk about lithium

because it's sexy, but copper, you know, there's not a massive amount of copper. I don't think I actually, you know, we can talk about peak copper.

I, think we're amazingly ingenious at coming up with new ways of, working out different refining methods and so on. And actually, to me, the amazing story of the last kind of 100 years is that copper, a lot of people have been predicting peak copper for quite some time. they've been, there's a whole thing in my book about this battle between, or the kind of argument, the bets between this economist, Julian Simon and Paul Ehrlich, the, you know, the population bond guy and that whole thing.

What's interesting to me about That is a lot of people have taken it as this parable to say. Oh, it's fine We'll always have enough of everything to me. What's interesting about it is, you know How did we not run out of copper? We know we didn't run out of copper because we just we made the trucks at copper mines We like 10 times bigger than they were before.

And so we just shifted, we, completely changed the economies of scale in copper mining in the 1980s. You had these kind of massive trucks, the ultra class vehicles, and suddenly our productivity Our ability to blast rocks out of the ground, to refine them in massive quantities, kind of went through the roof.

This is a productivity story. You know, I call it, it's almost like Moore's Law. It's a productivity story that no one really talks about these days. But the upshot of that was that we were able to mine ever more copper from seemingly lower, kind of more junk rock, and we didn't run out of the stuff. And so to me, I look at that and I'd say that's a story of ingenuity and our ability to kind of confound those who are worried we're going to run out of things.

But I don't know how long that

[00:49:43] Nate Hagens: can last. M. With a big asterisk of oil and energy were cheap and abundant during that period. E. Right. Right. Exactly.

[00:49:52] Ed Conway: And also, and oil with the energy intensity of copper mining went through the roof at the same time. And like, yeah, the scale of the trucks did.

And also the water intensity and all of these things along the way, none of which was really.

So

[00:50:07] Nate Hagens: the way I think about these components, and let's take copper as one of them, is there are zillions of tons of copper, technically, in the Earth's crust. but, the, Amount per ton has declined by a factor of 100. in my country, in the 19th century, we had places in Montana that had 40% or grade, in the early 20th century.

For the whole United States, it was 4%. You would get a hundred tons of rock and you would get four tons of, copper out of it. Now it's 0.4%, so we need more and more overburden. We need more complicated trucks. Like you were saying, we need more, water and we need more energy. So to me, this is one, another one of those stories where oil, forget about the peak of oil, just the peak of oil, of cheap oil, oil, ubiquitous and affordability ripples into all of these other sectors.

copper isn't going to peak and decline because we're running out of copper ore per se. It's because of all the costs and the inputs needed to get it. And

[00:51:22] Ed Conway: if you look as I have kind of, I've been to big copper mines, you know, what is a copper mine? It's a process of getting some rocks out of the ground, taking them to a refinery and crushing them and then doing all this processing.

So it's actually a lot of it is basically the trucks. it is those trucks. It is the trucks going all the way from the bottom. You know, I went to this mine called Chukicamata, which is, the biggest hole in the world, the biggest man made hole in the world, supposedly. In Chile? Yeah, in Chile, exactly, yes.

and it vies with, Bingham Canyon within, in Utah as, for the claim of being the biggest man made hole in the world. and this place has been getting copper out of the ground back in, you know, In the early, era when it was kind of Edison, and it's still getting copper out of the ground in enormous kind of quantities today.

what's, kind of striking about that is when you're just standing there, watching it, I saw the blast, I saw the trucks going up, it's just this procession of trucks, you know, going up. 24 7. And so it is, massively, and they're all running on diesel, it's massively energy intensive, and that's before you get to the kind of refinery.

So I, you know, I agree, and I don't think that's properly accounted for, when we think about these things. And when you think about the fact that in the next, you know, 20, 30 years, we need to mine more copper than we ever have, as a species, before,

[00:52:52] Nate Hagens: if we're going to fulfil these, you know, If we aspire to net zero, which I have many issues with, but just focusing on this issue, we need between 10 and 100 times, I mean, depending on the study, copper, like massively more copper than we currently have because these transmission lines are as big as my leg made out of copper.

[00:53:14] Ed Conway: They're extraordinary, aren't they? Yeah. Yeah. And they run for miles, and like, you can't really substitute aluminium, you can do some aluminium for, kind of undersea high voltage cables, but you're gonna need crazy amounts of copper, especially for cars and things, so yeah, it's, I think copper is actually the one we need to be talking about when it comes to energy transition materials.

[00:53:41] Nate Hagens: so let me, ask something that I'm, not sure was in your book. but let's, assume that copper is essential and we're going to need an order of magnitude plus more copper based on, the supply requirements of energy transition, at what point does water. Or local environments and social justice in some of these areas, like you were in Chile, but a lot of places in the world where the copper is located, there are, there is a social issue and a water issue because the water is really necessary in Chile and other South American places.

And that water is being displaced from other uses. Did you come across that issue? And what are your thoughts?

[00:54:29] Ed Conway: Totally. Totally. It's bang on. It's these, this, the, Atacama Desert where a lot of the world's copper is, and lithium, by the way, is the world's driest area, save for like an area in the, I think the Antarctic.

It is the world's driest desert. And, there are parts where you've never detect, kind of had any rainfall. And so where's the water coming from? A lot of it's coming from underground aquifers where it's been. Locked up there. You're mining the water. You're mining the water in order to help you refine the copper and the lithium.

so I, again, that the environmental consequences, I think one of the biggest obstacles for net zero, it's not necessarily the technology. well, we can have that conversation, but I think one of the biggest obstacles is that you're, running into deep reluctance amongst people who live near these resources that you need to give you the resources, and it's been pretty easy thus far, but a lot of people there, when I talk to people in the town nearby that mine, they're terrified about arsenic levels in the ground and in the air, They're tearful about, terrified about the kind of respiratory diseases that, that they're encountering in young people there.

and that's just the beginning of it. You know, you've got problems with the tailings dam. Okay. For this, for this particular mind. So that's the, toxic waste dump. Basically, it's only, it's not majorly toxic, but it's still toxic. The tailings dam for kata, and bear in mind, they only really started putting this stuff into a dam a few decades ago.

Before that, they just. Put it into rivers and let it run down into the sea. It was terrible. The tailings dam is bigger than Manhattan. That's the toxic waste dump for this single mine. Okay. And if we are going to fulfill net zero, we need another three of these mines every year between now and net zero, now in 2050.

[00:56:29] Nate Hagens: So as a, as an economist or, someone who's economically trained, let me ask you a naive question. Do the standard runs of the math of net zero by these think tanks around the world that are promoting the energy transition, do they just look at the amount of molecules of copper and lithium that are available in the world and extrapolate that we will access them without oil or diesel limits, without social villagers worried about arsenic limits and without water limits?

Is it Kind of a reductionist analysis, or what can you say to that?

[00:57:09] Ed Conway: The answer is no, they don't go into any of those considerations. I mean, the International Energy Agency does separate reports on this stuff. It's not like people aren't thinking about this. I mean, definitely people are thinking about it.

but putting that together and into a cohesive thing, you know, a report that says, well, hold on. No. And actually, I think to some extent I find it worse than that because I struggle a bit with these. With some of these net zero models, because if you look at the models, so for instance, take the, probably the best one is from the International Energy Agency.

That model, in order for the world to get to net zero, you have to assume that places like Sub Saharan Africa, In terms of just their energy consumption, and this is not primary energy, this is, I think, secondary, and, you know, this is, like, green energy, any energy per capita, they're assuming, basically, that these places are just gonna be green energy.

have the same amount of energy consumption in 2050 as they do today. In other words, zero development. And that's enormously problematic. You know, if you're assuming that India isn't going to be able to develop, then why are they going to sign up to net zero? and I talked to policymakers in many of these countries and they find the whole exercise to be deeply hypocritical.

And I can understand why, because you've got The rich world, us, saying, Okay, well we've got this amount of energy per capita, we'll kind of tone ours down a bit, but you're never going to get anywhere near ours. And that is what the models kind of say, and I know that's not true. What they want to, how they want to put it, but that's how you answer the question of here's how we get to net zero in some of these models, so yeah, there's problems that go even beyond

[00:59:00] Nate Hagens: that, Nate.

And it's even worse than that, and I don't want to go too far down this path, but As energy and materials were abundant and cheap and the world had this, general upward trend in growth, there was peace, and, global commerce and globalized supply chains. My country, and I suppose yours as well, is now potentially at war in,

in at least two arenas, if not, three, because there's saber rattling with China and Taiwan, et cetera.

So Russia. Not by a GDP sense, but by a natural resource mineral energy sense is one of the richest countries in the world. not by a dollar GDP, but we have to maintain these international agreements to reach these net zero goals because all this stuff is complex Byzantine supply chains. And so that's also a risk on top of water and social justice and other things.

[01:00:06] Ed Conway: I think it, is. And I think even even leaving aside net zero, the world that we inhabit today is a consequence of globalization. You know, pretty much every product you're, touching the technology that we're using to communicate, the technology that people will be listening and watching this on.

That, that could not happen without supply chains that bestride the globe, at least in its current form. And if you're going to be kind of changing the nature of globalization, so you can't get stuff from China anymore, then the consequences are pretty unfathomable. Like one example, so this is a tiny micro example.

I went to this place, this factory and just outside Birmingham in the UK. So in the Midlands, in our, what's left of our industrial belt. They used to make the nibs that go into pens, like old fountain pen things. These days, they're really good at metal pressing, okay? So they're really good at making anything that's got kind of really incredible mic micron accuracy, pieces of metal.

And they were doing they were they had some particular machine that was churning out loads of a particular little bit of metal. And I said, what's that? They said it's an electrode, and it goes in the rearview mirror. of, of your car, and that's what enables it to do the auto dimming function, so you don't get blinded when someone puts their, headlights on behind you.

And I said, how many of these are you making? This is like Little Factory in Birmingham. They said, we're making hundreds of millions. because they're only tiny little things. they are responsible for, Half of the world's car rearview mirrors. So this little electrode goes from this little factory in Birmingham, it goes to the factory in China, let's say, probably China, where they're making the rearview mirrors.

And half, if you've got a car, there's a 50 percent chance that car That rearview mirror has that little thing from this single factory in Birmingham. Now if you just imagine that and multiply it by, I don't know, a thousand, a million, whatever number you can think of, for all of the little components floating around the world, they, it's, it is so complex that you can barely even get your head around it.

But that's kind of the nature of modern globalization, and I think that actually It is more concentrated and more located and it has more pinch points than we understand right now. And that's before, you know, Nate, we get to the question of, okay, we need to make this extra technology we don't have right now.

How are we gonna do it in a cheap way that everyone can afford it? So I completely agree. I think. I think, but here's, the all. I would say that if there's one subtitle of the book that I, that isn't in there, but is the point, it's how can we begin to fathom. The future, if we don't understand the present, and that's the point, we need to understand how the world works right now, and that means understanding the basics, and I just don't think we understand the basics before we even get to the, complex stuff, and I, when I say we, probably not your, you or your listenership, but like policy makers and

[01:03:16] Nate Hagens: everyone else.

I totally agree with you. I know when the Fukushima, earthquake happened, Ford truck, in, Detroit had to shut down, their manufacturing plant because there was this pigment, for the, paint that only came from Fukushima Daiichi. And, so I imagine you have insights into how salt and sand and copper and oil and All these things, they don't work in isolation, and they're all creating these wildly complex supply chains.

And I think that coupled with we're at the apex of a 50 year plus period of import substitution, where we take the economic, theory or, observation of comparative advantage, where you make guns or butter and you put all your resources into the thing you're least worst at. And the world is better off.

But in doing that. In getting more efficiency and more profits in the world, you have countries that are specializing in one thing and they've lost the ability to do all the

things. And I would think that researching your book, you would have had a, like an increasing gut feeling that is our situation.

What, do you think about that?

[01:04:34] Ed Conway: A sniff of it. you know, I've got little anecdotes like that one. And that's a great anecdote of yours about the, about Fukushima. within the economic literature, there's very few people who are working on this. Shockingly few. There's a few, there's a guy called Richard Baldwin, who's really good, who works on some of this stuff, out of, American, but he works out of, Switzerland.

And a few other economists who are looking at this, the structure, you know, nodal relationships of, globalization, but it's just, we, our understanding of this is very primitive and like I say, you just have these moments, like I had that moment in the factory in Birmingham, a moment where I'm standing in the kind of, in the, place where they make chlorine and just thinking, it's all so fragile.

It is so fragile right now.

[01:05:21] Nate Hagens: Why

is our, thinking sophomoric on this? Is it because we just think that dollars or pounds or the market, are just some natural law that will solve these things?

[01:05:35] Ed Conway: Yeah, I think, that we've been, first of all, we've been encouraged not really to think about where things come from.

So I, secondly, I think that because the majority of us these days work in services where we don't actually encounter physical production, you know, go back to what you were saying earlier. I, like, I agree. I think everyone who's studying economics should go and see how things are mined and how you get the materials that eventually become the products you use.

But I also just, I do think that, you know, and, Understandably We believe that the market will take care of it itself. And a lot of, you know, frankly, the market has taken care of itself, but the consequence of the market taking care of itself is you

have these factories which are uber specialised in making that particular little electrode, and they are, they're pinch points.

And until those pinch points explode, you don't really know about it. And I just, I don't think it's advocating central planning to say, hang on, shouldn't we just understand this a little bit better than we do at the moment? And I do think actually that, you know, the Biden administration is trying to do something about that, the commerce department, but it's so early days, you know, they tried to do that with chips.

Like the chips act was interesting because it was like, okay, let's start to try and understand the supply chain and we'll understand, try and understand the supply chain for chips. And obviously it's, primitive, but. There are some people who say, and I think it's an interesting kind of analogy, is what they're doing now similar to what was happening in the 1930s and 40s when GDP was invented?

Like trying to think of a new picture of how you understand the world. And that's kind of, I think, what we probably need to do right now, because as you said earlier, We are kind of, we're not in Kansas anymore, we're in a different world. It may be we're in a cold war, maybe we're already in a hot war, and in that circumstance, think back to the binoculars in the UK, we're going to hit an awful lot of those

[01:07:35] Nate Hagens: moments pretty soon.

And, based on your visiting of a lot of these minds and all the research that you've done for your book and in your job, can you speculate on what a couple of the binoculars of the 2030s might be, based on your insights? I mean, well,

[01:07:55] Ed Conway: batteries is kind of the obvious one, isn't it? Because it's just so dominated by China.

I mean, when you look at batteries, China is just, is so far ahead. And batteries are a critical technology. I mean, and you could say the same thing about solar panels, except that we have alternative energy sources, don't we? So it's not like everything grinds to a halt if you don't have the solar panels.

semiconductors, interestingly, the U. S. still is way ahead on semiconductors, I think. and, China has put Invested billions, I think maybe hundreds of billions, into trying to create a silicon chip industry, and it has just struggled to do it. It's really hard. It's just really, hard. And interestingly, that goes all the way down through it, so they still are not very good at even making the silicon wafers that then go into the silicon plants.

Not the uber high quality ones. And I try to go to, I try to visit these places where they make silicon wafers. Everyone said, listen, we can talk about it, but you cannot come and see it because we are just terrified about China stealing the IP here. So there are still some areas where the U. S. is kind of, has got a lot of that supply

[01:09:05] Nate Hagens: chain.

Those are three good, examples. My, my guess is that neither you nor I nor anyone today could imagine it's going to be something like that factory in the UK with the pen nibs or something like that will surprise everyone. Oh my gosh, I didn't know we were so dependent on X.

[01:09:26] Ed Conway: it'll be the thing we didn't expect.

You know, there was this story in the UK where, so we have, there's a couple of fertilizer plants actually. You know, side story, but both of them are now shut down and the UK is, for the first time in its history, not making ammonia fertilizer domestically. For the first time since the Haber Bosch process, we don't make it here, we import it all from the US and from North Africa.

That's another story. One of these plants shut down because of high energy prices and all of a sudden the Department for Business was getting all these calls and I think the Agricultural Department was getting all these calls from like pig farmers. And they were saying, this is a real issue for us. And they were saying, well, what, hang on, why is the shutdown of this plant?

Is it something to do with fertilizer? And they said, no, it's nothing to do with fertilizer. This, place, which was making ammonia as a side product used to produce the majority of the country's carbon dioxide in canisters, CO2 in canisters. And we, the pig industry use that CO2. in our kind of stun guns to slaughter the pigs.

So the shutdown, and there's fizzy drinks and other things, but the shutdown of one factory making one product basically meant that suddenly there was no bacon on the supermarket shelves. That's your

[01:10:45] Nate Hagens: next book. Is the complexity underpinning all these materials? it's needed. Someone needs to write that.

[01:10:54] Ed Conway: But when this happened, it came as such a shock. I remember talking to people within like Downing Street. So where the government is here and they were like, we had no idea. We didn't even have a map of the chemicals industry. And then after that, they've gone out to the various chemicals producers in the UK.

I know this cause I've heard and said, Hey, could, you guys just. So we know which things connected to which other things and they're like, well, we can try, but it's, the most complex thing you can possibly imagine. so yeah, it's amazing. It's kind of amazing. It's inspiring as well, though, isn't it?

Because it's like this, all this stuff that you've never heard of is happening. It's all out there happening right now. And it's part of how we stay alive.

[01:11:37] Nate Hagens: I think. Humans are incredibly clever and bright, and I think we could map this. The question is our governance system able to handle this complexity?

That, and our economic system, that's a separate question. I

[01:11:54] Ed Conway: think it's, I think it's almost, like, they would desperately like not to have to handle it. You know, like, no one wants to Central planning was not a great success, was it? and, so regardless of whether we now have the computers that could do what the Soviet, you know, computers couldn't do, I don't think anyone wants to kind of go down that road and I can understand it because human ingenuity is, there's no way that people in central authority can try and kind of account for that.

But I do think we're somewhere we just, We went so far hands off, and we just didn't want to even think about how the world actually worked. You know, there are lots

of ways. back in the day, there's this economic, idea called input output tables. And the idea is basically, there's this guy Vasily Leontiev, who, what, he actually won the Nobel Prize for it, back in, I don't know, when it was, the 20th century, middle of the 20th century.

And the idea is basically You can look at one part of the economy and say that the output from let's say fiber optics go into the social network sector they go into the service sector they go into and then you kind of basically saying Fiber optics connects to all different bits of the economy this way and you build up a Bigger and more granular picture of how the economy works.

So those tables in theory, we should be able to make those tables for all of our economies. And we get a better, richer picture of how GDP actually operates in practice. You know, the input output tables that exist, for UK, it's like one bloody spreadsheet. with maybe 60 sectors on there that in no way can encapsulate the complexity of our economy.

So I just think we could do more work on this, and I hope there are PhD students out there who are doing the stuff that will help inform this, because we're living in a world where, I think there's a, kind of, there's an imperative from the energy transition, which says, okay, if we're going to make this happen, we've set ourselves this task, we can argue about whether the target, the objective is, the right one.

We've set ourselves a challenge. In order to get to that challenge, you need to redo the industrial revolution all over again. You need to rethink how you're smelting metals. You need to rethink how you're kind of making cement, all of these things. To do that involves a crazy amount of research and a crazy amount of investment.

And if we're going to do that, then at the very least, we should understand. You know, how it might actually kind of fit together with other parts of our economy. And right now we don't have that at all. We just have pretty vague, ideas.

[01:14:43] Nate Hagens: So what would be, your recommendation either to universities or to governments?

what would they do in response to the things you've outlined in this interview?

[01:14:54] Ed Conway: I think we need to rediscover things like input output tables, which are an alternative way of making GDP, basically, and there's a few people who are into that. Interestingly, you find them mainly in countries like India, where they are just more kind of focused on where things come from.

I think it's kind of tangential, but you mentioned kind of universities, and the thing that really shocked me when I was researching this book and talking to lots of people within the mining community is there's a real dearth of interest of amongst young people in getting into resources.

there's the, Camborne School of Mining is one of the, top mining schools in the UK. one of the oldest mining schools in the world. they can't get enough students to fulfill their main, course, their masters in mining engineering. They can't get enough students, so they've shut down the course.

but if we're gonna solve all these problems we've set ourselves, and they can't get the students by the way, because everyone wants to go into subjects like environmental science, but if we're gonna actually fulfill all of these targets we've set ourselves and, you know, get to net zero, we're gonna need to do the mining to do it.

And so I do worry that, the SKU has gone far too much into naval gazing and far too little into technical solutions and engineering and mining, and that they're just, they're the bad guys, aren't they?

[01:16:26] Nate Hagens: Energy and material science underpin, environmental science in some ways, but in another way, the energy, I mean, this is my view, the energy transition itself is, much more than about energy.

It's about our relationships with each other and with nature. It's about our values. It's really a change in consciousness of what is our role, and our fiduciary on the planet. It's not about the supply, chain only. it's, both human demand and, the supply.

[01:17:00] Ed Conway: but we're not having that conversation.

No, that's the thing. Everyone's too, everyone's way too afraid. about, about positing that our lifestyles might have to be a bit different.

[01:17:10] Nate Hagens: Well, let me ask you on, on, on your professional day job, what do you see the role of journalism and media in accelerating, expanding that conversation? And have you come across some sort of a social glass ceiling with the intensity and complexity of these topics that it becomes too uncomfortable to write about, these issues?

I mean, what, is your experience and what are your hopes? I

[01:17:37] Ed Conway: think there's very few people who are discussing this, who are putting them all together. you know, you're one of the few. And it's, it is, it's surprising to me how often when we as journalists kind of talk about, It's something like net zero.

The focus is only about, I don't know, it's kind of about catastrophism rather than about pragmatically, what do we do? Environmental kind of journalism a lot of the time is just about, okay, there's a fire happening somewhere, we need to get a camera in front of it. I hope, that's, I mean, it's not to say that we don't need to document what's happening in the world, but I just think, like, that's the catnip that a lot of people seem to be drawn towards, as opposed to, okay, what are we actually doing now?

How are we going to do it? what are the inspiring stories here? Because there are inspiring stories about You know, us as a species doing amazing things and how we can kind of repurpose that, that knowledge and expertise to, to make the next generation of stuff we need, to make. I don't know if I've encountered, a kind of glass ceiling so much as just, there just need to be more people talking about this stuff.

I think the interest is there, you know, the, this book that I've written seems to be, of interest to, to, to people. it's just. I mean, getting people to engage. And I think the way, you know, one of the ways to get people to invest, because I think a lot of people have heard so much scary stuff about, energy and climate.

They've got preconceived notions about goodies and baddies, you know, oil, bad kind of solar, good, whatever, all of that stuff. the, I, think that A more nuanced, complex approach to this is the only way that we're gonna actually get people to engage. Because it's just been too, it's been too shouty up until now, and too much about fear, and I just, that doesn't work forever.

[01:19:53] Nate Hagens: That's what humans do. we're shouty. but we also have conversations like this. my colleague and friend, Olivia Lazard, points out that on our way to decarbonization, there will be a rematerialization, which brings us right to your Ballywick here. And I think That needs to be understood and discussed a lot more.

A couple more of final content questions before I get to my closing questions that I ask all my guests. what about, recycling? because if these minerals and materials, the ones you write about in your book, I mean, oil can't be recycled, but the other ones could be in, in theory, what, are your thoughts on the current state of recycling and what might be possible?

The current state is

[01:20:47] Ed Conway: not good at all. We're pretty good at recycling. We're okay at recycling copper. We're pretty good at recycling aluminium. We're very good at recycling steel, because steel's magnetic and so it's just easier to sort. I think recycling will, definitely help.

Like, I'll tell you what, so one statistic that I find quite encouraging, I'm into data, and, The, like a really good way of, kind of understanding, economists like to talk about GDP per capita when they're talking about our living standards. This country has high, you know, whatever it is, kind of 50, 000 GDP per capita.

This country's got kind of 10, 000, et cetera, et cetera. I, like, for me, an even better way of understanding the difference between nations is the amount of steel embedded in a nation. per capita. So we in the rich world have maybe 15 tons of steel per capita. And that steel is kind of everywhere around you.

It's in the building that you're inhabiting, it's in your car or cars, it's in the public transportation system, it's in schools, it's in hospitals. That, amount of steel, 15 or so

tons, seems to add up to a developed world standard of living right now, at least. In some countries in the world, like sub saharan Africa, it's less than one tonne of steel per capita.

It's like 0. 1 tonnes of steel per capita. And if they're, you know, if these countries are going to develop, they need public transportation, they need rail systems, they need, you know, hydroelectric dams. There's quite a lot of steel in there. you need all of these different things, hospitals, schools, and so on, and cars.

That's a lot of steel. And there's, a challenge there, which is to say that right now, we have no way of mass producing steel in large quantities that isn't really carbon intensive. And when I say really carbon intensive, I went to a few blast furnaces in the course of writing this book.

You know what the main product of a blast furnace is? It's not pig iron. It's carbon by weight. The main product of a blast furnace is carbon dioxide. The, steel that rather the pig iron that comes out. is a byproduct. And you know, making the steel that these countries will rightfully expect in order to improve their living standard is one of the biggest challenges that we are facing as a species.

And again, I don't think that's anywhere encountered in any of these models for, net zero. However, the thing that gives me some hope, okay, is that once you get to 15 tons, and I'm not saying that 15 tons is the right level, okay, there's, we can have a good conversation about that, but once you get to 15 tons, It does seem to plateau.

Like, without people doing anything, without any kind of behavioral encouragement, people, there is a level which seems to be kind of enough. And in all of the kind of literature elsewhere I've seen, you know, those things are a bit scary because we just do seem have a, seem to have a propensity to consume.

But there are kind of certain, it does, there are, hints that at one point we might get to kind of enough, and with steel it's good because we can keep on recycling a lot of it all the

[01:24:02] Nate Hagens: time. There's a Swedish word, lagom, which means enough or the good life, and you don't need more than that, and, I, that concept.

However, this brings me to, a topic, which is how I met you. you had an unbelievably detailed and information dense Twitter thread. On Jevin's paradox and how technology making things better. And you used early in the thread, an example on led lighting and how it got cheaper, and then we just expanded the number of lights.

and I've actually used some of your charts in my presentations on, lighting and how we've gotten better and better at lighting, but we've used more and more energy for. forelighting. what are your thoughts on Jevons paradox? And could you just, give us a brief summary of, that phenomenon?

Well, it's just to say

[01:25:04] Ed Conway: that, so, it goes back to this guy, William Stanley Jevons, who was an economist, in the 19th century. He noticed that, the steam engines of the day were getting more and more efficient with every iteration, you know, so you went from the kind of Newcomen engine all the way through to the Watt engines, and they were producing ever more, movement and energy, from ever smaller amounts of coal.

So the energy density was improving, or at least the energy throughput was improving. but he noticed that, hang on, rather than actually just banking that and doing the same amount of stuff, instead we were just coming up with ever more reasons to install new steam engines and burn more coal.

And his book basically said, if that continues, it's kind of a Malthusian really, if that continues, then we're just gonna run out of coal and it's, you know, it goes up and up. And so the Jevons paradox is just to say, sometimes when you have an efficiency gain, rather than banking it and doing nothing and just subsisting on, like you say, that's Swedish word, just subsisting with what you've got at the moment, is there something innate in humankind that makes us want to just do more stuff?

And it does seem like there are quite a lot of examples of Jevons Paradox. If not Jevons Paradox, so Jevons Paradox basically says all the efficiency gain is eaten up and you end up actually expending more energy in the future. That's the ultimate Jevons Paradox, but there's a kind of micro version of that which is to say You

might save some energy, but then you'll expend a little bit more along the way, so that's called the rebound effect.

and there are quite a lot of examples of both of the rebound effect and Jevons paradox throughout history. The example I chose was just LED light bulbs because It's very visual, isn't it? They are amazing in terms of their efficiency. But you don't have to go far when you walk around your city, particularly at winter, just to see how much LED there is.

We are lighting up the world far more than we ever did before. You know, every park in my part of London has a Christmas display with all these lights everywhere. And The question is whether we are installing so many lights that it eats up all of that efficiency gain from the fact that LEDs are much more efficient.

And that's an unanswered question at the moment. but, the, challenge with net zero is do essentially, is it incredibly difficult? We're not actually banking all those efficiency gains that we kind of promised that we are relying on to get to net zero. and a lot of people I kind of, I talk to and respect within the energy field.

They think that it is going to be harder because we just have this proclivity. Look at AI. AI is a really good example. You know, look at all those server farms that are being set up. The amount of energy consumption in the U S is going to go up a lot because all those server farms have to be domestic.

And that you need that to run the algorithms. That being said, I am just like, I guess optimistic about this. And I do think that the other side outweighs it. I do think that AI will potentially help us come up with the solutions that provide more efficiency. But in the, you know, in the short run on the way there, we're going to burn a lot more energy to get there.

[01:28:42] Nate Hagens: But if they come up with solutions that give us more efficiency, isn't that just

[01:28:48] Ed Conway: Do we then have another Jevons Paradox with those solutions? Yeah, like LED example

[01:28:52] Nate Hagens: on steroids. It's going to make us better at everything and we're just going to consume more. Yeah. So I'll, Yeah. I'll query what you just said.

Is it something about humans that makes us want to consume more or is it something about our current economic system? Well, that's, yeah, that's a really good question.

[01:29:13] Ed Conway: I don't know. I hope, I, hope it's the economic system. Let's hope so. I mean, because, and I think, you know, that's, it's, that's a very plausible argument.

we are, like, the amount of waste and overconsumption in our lives is crazy. And, you know, everyone kind of knows this. we all probably drive cars that are a bit bigger than we need, although I've got kind of a big family, so that's my excuse. But, you know, like, we've all got our excuses. I do think that It is possible to live with less consumption.

And actually, you know, the funny thing actually, Nate, so I'm not like a big believer in imposing taxes to try and change people's behavior, but I understand that is necessary a lot of the time. But I do think that more awareness of, just awareness of what the world is and what it takes to get the stuff that we use.

I think that's quite a powerful thing. And I, my, my guilty secret, my guilty pleasure, used to be, I used to buy loads of gadgets all the time. I loved, you know, the new thing, whatever the new thing was, I would buy it. since writing this book and understanding more about how things actually, are made and get to me.

I respect them more. Like I respect the stuff I'm touching more and I buy less of it. And I am a, you know, I'm no, paragon of virtue on this, but I, think that's part of the route. I think if we all understand this stuff a bit more, then maybe we'll be slightly more in tune with the world. And if you understand that concrete is an amazing thing and it's part of our environment to some extent.

You understand that the concrete in London comes from this drowned land that was submerged for thousands of years. And you understand that the steel that we're kind of surrounded by has gone through this crazy process in a blast furnace

which creates more carbon than it does iron. I just think a lot of that can help us, you know, maybe I'm optimistic but I think that's helpful.

I think if we kind of spend

[01:31:19] Nate Hagens: more time thinking about that stuff. I totally agree. We have to understand it. Understanding leads to appreciation. Appreciation leads to gratitude and conversations and behavior change, ultimately. And that's why your niche in this as a journalist, I think, is really important.

So God, Godspeed, Gaia speed to you and all your efforts. If you have a few more minutes, I have some closing questions. I ask all my guests. and if you've watched my podcast, you probably know what's coming, but what, I mean, you're, an optimistic fellow. and, but you also have, taken the red pill a little bit with, this research into this book.

So what advice do you have to the viewers and listeners of this program who are aware of how the complexity of all this, fits together and, want to make. changes in their own lives, in their communities, with their families. Do you have any personal advice? I guess, I guess, you know,

[01:32:20] Ed Conway: to underline that there's a story, and I've thought about this a bit when trying to kind of explain what's this book about.

Cause, you know, partly it's about like stuff materials. Partly, it's about the energy transition. Partly, it's about the fact that we've committed to something incredibly difficult, far more difficult than anyone knew, fathomed at the time that they signed up to it. We signed net zero into law in 2019. No one in that room had a clue what that would actually entail.

Not a clue. They told, you know, like, they've admitted this, you know, later. so they now do have a clue? Yeah, well, no, but they do have a clue. They know that they don't have a clue, you know, which is progress of sorts. but so, there's various different things that, that like I feel are powerful points, but I think actually more powerful than the things that people have responded to more, which I think is useful.

I hope for your kind of listeners, the wonder. And the inspiration, the positive stories about the things that we are capable of doing as humans really does help to inspire people and to power through, you know, so much of the way that this discourse has been kind of has happened in recent years has been about fear and has been about threat, but there's wonder too, and there's amazement.

The story of how we managed to invent lithium ion batteries is an amazing story. It really is, like, we, did something that could not be done before. There are loads of different technologies out there that a lot of people thought we'd never be able to come up with. You know, being able to make those transistors that go onto, that are smaller than the wavelength of visible light.

the nature of how You'd create the lithography machines, extreme ultraviolet lithography machines. A lot of people thought that could never be done. It was just, they thought it was just too sci fi. And a lot of people thought we'd never rediscover the recipe for concrete. A lot of people thought solid state semiconductors would never happen.

I just think, you know, we are pretty amazing at doing stuff. And then when we've done it, when you've, suddenly when we've invented the silicon chip, and when we've invented the extreme ultraviolet lithography machines, technology that enables us to have transistors that are so small they're smaller than the wavelength of visible light.

we just got our phone and then we just complain about how it's slow, you know? I think if we rediscover the wonder and then say, listen, It is by doing stuff like that in the future that we are gonna have a sustainable, amazing world to live in. I think the hope side of things, there's some great stories of hope, and I think we need to, kind of, to, focus on them just as much as threat, because people are tired of threat.

[01:35:10] Nate Hagens: And what sort of story or narrative or advice would you give for a young person starting their education or starting their career, being aware of all these, intricacies of the human situation? I'd say,

[01:35:27] Ed Conway: so back to that thing, I, the thing that I despair about is that a lot of people are going into kind of like, like I did as well, frankly, you know, social sciences and literature.

I enjoyed it. if you want to choose a way, if you want to save the world, then one of the best things you can do right now is to understand the physical world around you and work out, you know, try and, you know, whether it's mining, whether it's energy, these are, and engineering as well, these are, the occupations and the roots that are going to be absolutely central to, to making a better world a reality in, future, and so I would say try not to take for granted these kind of demons, demonization that a lot of people have just lazily accepted that oil is bad.

I mean, yeah, there's lots that's bad about oil and about carbon emissions, but we're not gonna, we're not gonna make batteries if we don't do some clever things with oil. You know, we need, where do you get the anodes from? You know, from oil. We're not going to do, Yeah, whether, if hydrogen ever becomes like an economic reality, it's not going to happen without some really clever engineering along the way.

and so I would just encourage people as much as they can to, focus on that rather than on the kind of shouty side of things, which, I guess I'm a journalist, so I slightly inhabit that world, but I have so much more respect these days for engineers, scientists, people who are actually working at the coalface, sometimes literally, but, you know, metaphorically as well.

[01:37:11] Nate Hagens: Well, you shout too, you just shout with facts. what do you care most about in the world, Ed? my children and,

[01:37:23] Ed Conway: the, world that they're gonna inhabit. And I've got, I've got, three kids and I've got another on the way. So I'm kind of slightly skewed towards the, kind of growing the population, side of the, of the world.

And I, yeah, I just, I, care deeply that they will have, A better world to inherit. I feel lucky that the world that I have is I'm incredibly privileged to be born where I am, to be, you know, living in the environment I am right now, and I just hope that it can be better for them. And I believe that it can be.

So I care about them and I care about them. That's more than anything else, you know. That's probably a bit of a slightly

[01:38:13] Nate Hagens: trite answer, but that's, it. Oh, no, it's an honest answer. Can it be better materially, given the constraints that you've laid out, or better in a, well being, different sort of economic system way?

[01:38:28] Ed Conway: Well, I just, I, think that, I guess it depends on what you mean by materially, because Resources per capita. Yeah, but, like, There's resources per capita isn't necessarily tied definitely to, you know, what we would conceive in our minds as standard of living, you know, I don't like I, I think I hope materially it's a kind of lower material resource dependency.

I don't think that necessarily needs to affect their standard of living. I hope that my material dependency will be lower in future. in fact, I think it probably is since having written the book and I'm kind of consuming less of stuff. I definitely don't feel my standard leveling has gone down.

but I, yeah,

[01:39:11] Nate Hagens: yeah. Excellent. I happen to agree. if you could wave a magic wand and there was no recourse to your, journalist position or reputation or anything, what is one thing that you would do to improve human and planetary futures?

[01:39:28] Ed Conway: Like I did this and I don't have a, I don't have a kind of like a kind of one word answer.

I, you know, none of my answers have been one word. I'm sorry about that. there's no, there's a kind of coordination issue here, isn't there? Like there's no shortage of. of lithium or sand. There's no shortage of a lot of this stuff, but we are living in a world now where, politicians and politics is quite scary.

You know, I just kind of wish that politics could become slightly more multilateral and collaborative. I, wrote a book called The Summit a few years ago. This is not an advertisement for the book, but it was, it didn't sell very well, unfortunately, but it was, about the, Bretton Woods Conference of 1944, you know, when a lot of kind

of economists and, Thinkers came from around the world to this place, this hotel in New Hampshire at the, towards the end of the second world war and did everything they could to try and create a new set of institutions that would prevent a third world war.

And they, they, did, you know, the system that they created, the Bretton Woods system was one of the most stable periods for the global economy in terms of number of recessions, in terms of the amount of employment, in terms of, The amount of inflation. So it is possible if people are working together to, to, create a better system and a better world.

but I fear that we're moving into a kind of a more tempestuous period right now, less multilateral, less collaborative, and more bellicose. And that, does concern me. So I wish that people, politicians would engage more. And, yeah. Could,

[01:41:16] Nate Hagens: we have a new Bretton Woods or the like?

Don't think so, unfortunately.

[01:41:21] Ed Conway: I mean, I think we, you know, if ever there were a time where we needed it, it would be right now. there's, in some senses, there's a kind of, there's a sequel to both of those books. So the material world and Bretton Woods, which says right now, the nature of the global trading system, With relation to things like manufacture of batteries, you know, it's a really good example.

So electric cars, China is massively dominant in already, okay, and it's going to be dominant because they are so far ahead on batteries, on cathode active materials, on all of that stuff, that, that will have big trade consequences and the US is going to respond in turn. And part of this partly explains why China has a large and growing current account surplus with the rest of the world.

And those imbalances with one country with a massive amount of savings and another country largely in debt are the kind of imbalances that led to the financial crisis we've seen in the past and the kind of imbalances that led to the 1930s and the breakdown of global trade that in turn led to the Second World War.

So you couldn't really have a better moment right now to be thinking in these terms. But no, I mean, we're nowhere near the world. Everything has to get a lot worse, unfortunately, before you start to put things back together. and yeah, obviously I hope it doesn't. I think by the time, if there were to be a new Bretton Woods, it would be because something had gone terrifically, wrong, unfortunately.

[01:42:49] Nate Hagens: This has been a fantastic conversation. I can't thank you enough for your, pitbull like curiosity of diving into this interdisciplinary subject professionally as a journalist. And let me know if I can help you going forward. because I really do think more people understanding the complexity of our energy and material foundation of our economies leads to better decisions.

Or at least gives us the possibility of better decisions. Do you have any closing words for our viewers?

[01:43:22] Ed Conway: No, just to say, listen, I'm, I, as I said at the start, I'm kind of a tourist in this, in the, you know, in this world. I just, I, It's the most fascinating thing to understand more about materials and energy.

It's been one of the most fascinating journeys I've ever been on. I'm still on it, and I'm still learning, and I've learned a lot from you and from your material, Nate, and from many other people within, the kind of connected world. It's a stimulating time to be alive. It's an exciting time to be alive.

and I, yeah, I hope that we can all just carry on encouraging people to, think in nuanced terms that doesn't disrespect the complexity and the wonder of the world we inhabit.

[01:44:08] Nate Hagens: Hear,

Thanks so much, Ed. To be continued. If you enjoyed or learned from this episode of The Great Simplification, please follow us on your favorite podcast platform and visit thegreatsimplification.

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